

ANNEX

X

(Norma
tive)

Cohere
nce-
Constr

ai

ned
Adapti
ve
System

S
Archite
cture
(CCAS

A

)

A

Stabilit

y

and
Failure-
Bound
ed

Design
Frame
work
for

Large

Complex
Systems

...

X.1

Scope

This

Annex

specific
as a
coherence-
nce-

constra

ined

adaptiv

e

archite
ctural
frame
work

intend
ed for
applica
tion to

large-
scale,
complex
X,

socio-
technic
al
system

S,

includi

ng but

not

limited

to:

*

Artificial
intelligence

system

S

*

Robotic

s and
autono
mous
system

S

*

Teleco
mmuni

C

ations

networ

ks

*

Energy
and
power
grids

*

Urban
infrastr
ucture

and

smart
cities

*

Critical

risk,
insuran
ce, and
safety-

critical
domains
s

This
Annex
is
technol

ogy-
agnostic
c,
domain

-

neutral
, and
design

e

d to

overlay

existin

g

archite
ctures
without
requiri

n

g

replace

ment

or

central

i

zed

control

■

■■■

X.2

Purpos
e

The
purpos
e of
this

Annex

is to:

*

Reduce

system

ic

failure

propag

a

tion

*

Maintai
n long-

term

operati

onal

stabilit

y

*

Enable
adaptive
e

evoluti
on
without
loss of

interna

|

integrity

y

*

Conver
t

failure
events
into
bound

e

d,
instruc
tional
feedba

C

k

*

Improv
e

predict

ability

under

uncert

ai

nty
and
scale

This

Annex

does

"not"

prescri

b

e

specific

c

implem

entatio
ns,
algorit
hms,

or

govern
ance
structu
res.

...

X.3

Normative

Design
Principles

es

System

s

confor
ming
to this
Annex

"SHALL

"

implem
ent the

followi
ng
principl
es:

X.3.1

Cohere nce

Constr
aint

The

system

SHALL

define

explicit

operati
onal
bound
aries

that

limit:

*

Feedba

ck

amplifi
cation

*

Propagation
radius
of

localized
failures
* Rate

of
structu
ral or
behavi

O

ral
change

These

constra

ints

SHALL

prioriti

z

e

continu

ity

over

optimiz

ation.

X.3.2

Adapti

ve

Recurssi

on

The
system

SHALL

be

capabl

e of

modifying
its
internal
|

param
et

ers,
behavi
ors, or
configu

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ations
within
define
d

cohere

n

ce

constra

ints,

such

that:

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Adapta

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ion

does

not

introdu

C

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instabil

ity

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Learning
does
not
exceed

structu
ral
toleran
ce

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Evoluti
on
remain

S

bound
ed and
reversi
b

le

X.3.3

Tempor
al

Integrit

y

The
system
SHALL

preserver
functional

continu
ity
across
time,

ensurin

g:

*

Bound
ed
tempor
al drift

between
n
subsys
tems

* No

manda

tory

global

resets
under
local
failure

* Long-
horizon
perform-
ance

remain

s

stable

Tempor

al

cohere

nce

SHALL

be

enforc

ed

indepe

n

dently
of
instant
aneous

system
state.

X.4

Explicit

Non-

Goals (Exclus ion Criteria

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System

s

confor

ming
to this
Annex
"SHALL

NOT"

be

design

ed or

used

to:

Central

ize

authori
ty or
control
Optimi

z

e
solely
for
speed

or

throug

hput

Enforc

e

ideolog

i

cal,
political
l, or
cultural

I

alignm

ent

Maximi

ze

short-
term
perform
mance

at

long-
term
risk
Imple

m

ent

persua

sion,

manip

ul

ation,
or
weapo
nizatio

n

logic
Create
depen
dency

on

singula

r

agents,

entities

, or

operat

ors

Requir

e

consen

sus,
harmony,
or
unifor

m

agree
ment

These

exclusions are
structural

constra
ints,
not
ethical

recom

m

endati
ons.

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X.5

Failure
Classifi

cation
and
Respon
se

Model

Confor
ming

system

s

SHALL

recogni

ze and
respon
d to
the

followi

n

g
failure
classes

■
■

X.5.1

Localiz
ed

Overlo

a

d

Description:

Saturat
ion of a
node
or

subsys

t

em

Requir

ed

Respon

se:

Local

load

redistri

b

ution
with
bound
ed

propagation
Outcome:

Degrad
ed
local
perfor

mance,

preserved
global
continuity

i

ty

X.5.2

Tempor
al

Desync

hroniza
tion

Descri

pt

ion:

Phase

drift

betwee

n
subsys
tems
Requir

e

d

Respon

se:

Increm

e

ntal

tempor

al

correct

i

on
within
tolerance

bands

*

Outco
me:
Phase

realign
ment
without
cascad

e

resets

X.5.3

Feedba
ck

Runaw

a

y

Description:

Positiv
e
feedba
ck

amplifi
cation
Required
ed

Respon
se:
Recursi
ve

dampening
enforced by

cohere

nce

ceiling

s



Outco

me:

Stabiliz

ation

into

bound

ed

oscillat

i

on or
steady
state

...

X.5.4

Data

Integrit
y
Degrad
ation

*

Description:

Noisy,
incomplete, or
advers

a

rial

inputs

*

Requir

e

d

Respon

se:

Confid

e

nce-
weight
ed
decisio

n paths

Outco

me:

Gracef

u

I

perfor
mance
degrad

a

tion,
not
failure

...

X.5.5

Human

–

System
Misalign-
ment

*

Description:

Incenti
ves
misalig
ned

with
system
health
Requir

e

d

Respon

se:

Metrics

anchored
to
long-
term

cohere

nce

Outco

me:

Reduce
d
exploitation

of

short-
term
optimiz
ation

— — —

X.6

System
Behavi
or
Under

Stress

Under
stress
conditi

O

ns,
confor
ming
system

S

SHALL:

*

Localiz
e
failure
before

system

-wide

impact

*

Preserv

e core
functio
nal
continu

i

ty

*

Maintai

n

bounded
adaptability

* Avoid
irrever
sible
structu

r

al

change

s

*

Contin
ue
operati
on

under

partial
degradation
ation

Failure
SHALL
be
treated

as

inform

ational

input,

not
terminal
error.

...

X.7

Integra

ti

on with
Existin
g
Standa

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This

Annex

is

intend

ed to

be

comple

mentar
y to
existin
g

standards,
including but

not
limited
to:

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ISO/IEC

AI

safety

and

govern
ance
frame
works

* IEC

functio

nal

safety

standards

*

Teleco

mmuni
cations
reliabili
ty

standards

*

Infrastr

structure
resilience and
risk

manag
ement
models

This

Annex

SHALL

NOT

supers
ede
domain

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specific

C

safety

require

ments.

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X.8

Confor mance Criteria

A
system
MAY
claim

confor
mance
to this
Annex

if it
demon
strates

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Define

d

cohere

nce

constraints

*

Bound

e

d

adaptiv

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mecha

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isms

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Temporal
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stabilit
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enforc
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Explicit
exclusion
of

prohibi
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design
objecti

V

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Docum
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failure
classifi
cation
and

respon
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logic

Verifica

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MAY be

perfor

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simulation,
stress
testing



or
operati
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eviden

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X.9

Expected
ed

Outco

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es

System

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confor
ming
to this
Annex

typically

y

exhibit:



Reduce
d
catastr
ophic

failure
probability

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Lower

system
ic tail
risk

*

Improved
long-
term

predict

a

bility

*

Increased
ed

resilien

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under

uncert

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nty

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Sustain
able

adapta
tion
over
extend

ed

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X.10

Summ
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Statement

This

Annex
establi
shes a
frame

W

ork in
which
system
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mature
instead
of
collaps

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by
prioriti
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cohere

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over

control

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adapta
ti

on
over
rigidity
, and

continu

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ty over
short-
term
optimiz

ation.
